

1. Background and Methodology

Introduction

This study was undertaken at the request of the Committee on Science, U.S. House of Representatives. The Committee asked the Energy Information Administration (EIA) to provide an analysis of the Final Rulemaking on Heavy-Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements, which was signed by President Clinton in December 2000.¹ Along with all other regulations finalized at the end of the Clinton Administration, the Rule underwent a 60-day review by the Bush Administration. On February 28, 2001, the Administrator of the U.S. Environmental Protection Agency (EPA), Christine Todd Whitman, gave her approval to move forward with the new rule, citing the great benefits to public health and the environment.²

The purpose of the rulemaking is to reduce emissions of nitrogen oxides (NO_x) and particulate matter (PM) from heavy-duty highway engines and vehicles that use diesel fuel. The rulemaking requires new emissions standards for heavy-duty highway vehicles that will take effect in model year 2007. Because the advanced emission control devices that will be required to meet the 2007 emissions standards are damaged by sulfur, and because the 2007 model year begins September 1, 2006, the rulemaking also requires the sulfur content of highway diesel to be substantially reduced by mid-2006.

The purpose of this study is to assess the possible impact of the new sulfur requirement on the diesel fuel market. The study does not address the impact of the rulemaking on vehicle emissions or public health.³ This study discusses the implications of the new regulations for vehicle fuel efficiency and examines the technology, production, distribution, and cost implications of supplying diesel fuel to meet the new standards.

A summary of the new sulfur requirement, the analysis issues identified by the Committee on Science, and the methodology of the report are provided in the remainder of this chapter. Chapter 2 describes emission control technologies for heavy-duty diesel engines, their effects on fuel efficiency, and expected costs. Chapter 3

discusses technologies for producing ultra-low-sulfur diesel fuel (ULSD) and the analysis approaches used in this study to assess their future costs. Chapter 4 discusses the impact of the ULSD Rule on oil pipeline operations. Chapter 5 addresses the issue of future supply of ULSD, particularly during the transition period in 2006, and the potential responses of refinery operators. Chapter 6 summarizes mid-term projections (2007 through 2015) for diesel fuel prices, based on a range of assumptions in cases analyzed using EIA's National Energy Modeling System (NEMS). A comparison of the assumptions and estimates from this study with those from other analyses is provided in Chapter 7.

Summary of the Final ULSD Rule

The new ULSD Rule requires refiners and importers to produce highway diesel meeting a 15 parts per million (ppm) maximum requirement starting June 1, 2006.⁴ Pipeline operators are expected to require refiners to provide diesel fuel with even lower sulfur content (somewhat below 10 ppm) in order to compensate for possible contamination from higher sulfur products in the system and to provide a tolerance for testing. Diesel meeting the new specification will be required at terminals by July 15, 2006, and at retail stations and wholesalers by September 1, 2006. This time schedule is driven by the need to provide fuel for the 2007 model year diesel vehicles that will become available in September 2006. Under a "temporary compliance option" (phase-in), up to 20 percent of highway diesel fuel produced may continue to meet the current 500 ppm sulfur limit through May 2010. The remaining 80 percent of the highway diesel fuel produced must meet the new 15 ppm maximum.

The ULSD Rule provides for an averaging, banking, and trading (ABT) program. Refineries that produce more than 80 percent of their highway diesel to meet the 15 ppm limit can receive credits, which may be traded with other refineries within the same Petroleum Administration Defense District (PADD) that do not meet the 80-percent production requirement. Starting June 1, 2005, refineries can accrue credits for producing any

¹U.S. Environmental Protection Agency, "Control of Air Pollution from New Motor Vehicles: Heavy-Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements: Final Rule," *Federal Register*, 40 CFR Parts 69, 80, and 86 (January 18, 2001).

²U.S. Environmental Protection Agency, "EPA Gives the Green Light on Diesel-Sulfur Rule," Press Release (February 28, 2001).

³Sources addressing the impact of the ULSD Rule on vehicle emissions and public health are included in the bibliography.

⁴The State of Alaska and the U.S. Territories have been exempted from the program.

volume of highway diesel that meets the 15 ppm limit.⁵ The trading program will end on May 31, 2010, after which time all refineries must produce 100 percent of their highway diesel at a low enough sulfur level to ensure 15 ppm at retail. The ABT program will not include refineries in States that have State-approved diesel fuel programs, such as California, Hawaii, and Alaska.

The Rule includes provisions for refiners in a Geographical Phase-In Area (GPA) that includes Colorado, Idaho, Montana, New Mexico, North Dakota, Utah, Wyoming, and parts of Alaska. The highway diesel provisions in the GPA are linked to the Tier 2 gasoline program. While the rest of the country is required to average 30 ppm gasoline sulfur requirements by January 2006, refineries in the GPA are granted an additional year to meet this requirement. Under the highway diesel provisions, refineries in the GPA that meet the ULSD standard by June 1, 2006, for all their highway diesel may receive a 2-year extension on gasoline compliance to December 31, 2008. To receive the extension, the refinery must maintain production of 15 ppm highway diesel fuel that is at least 85 percent of its average 1998 and 1999 highway diesel production.

Hardship provisions are allowed for small refiners with up to 1,500 employees corporate-wide and that had a corporate crude oil capacity of 155,000 barrels or less per calendar day in 1999. The small refiner provisions include: (1) production of 500 ppm diesel fuel until May 31, 2010; (2) the ability to acquire credits for producing 15 ppm highway diesel prior to June 1, 2010; and (3) a 2-year extension of the refiner's applicable interim gasoline standards if all its highway diesel fuel is 15 ppm sulfur beginning June 1, 2006.

Summary of the Request for Analysis

In its July 2000 letter (see Appendix A), the Committee on Science requested that EIA undertake a study addressing the possible supply and cost implications of the diesel fuel regulations. The Committee specifically asked EIA to address the following production and supply issues related to the ULSD Rule:

- The potential impacts of the Rule on highway diesel fuel supply and on costs to end users of diesel fuel⁶
- The potential impacts of the diesel fuel regulation on other middle distillate products such as home heating oil, non-road diesel, and jet fuel

⁵Credits for 15 ppm diesel fuel can be accrued before this date if the refiner can certify that the fuel is to be used in vehicles certified to meet the 2007 model year heavy-duty engine standards.

⁶The Committee also asked about several issues relevant to the proposed rule but not to the Final Rule: how potential supply might change if the effective date of the diesel regulation were later and did not overlap those for gasoline sulfur requirements, and how potential supply would change if the ULSD requirement were phased in.

- The cost and availability of ULSD imports
- The impact of the Rule on refinery operations
- The impact of the Rule on fuel efficiency (related to engine after-treatment devices) and on diesel fuel demand
- The cost of current and future technologies that are expected to allow refineries to meet the new sulfur standard, and their costs
- The likelihood that the necessary technologies will be adequately deployed to meet the new standards.

The memorandum also identified a number of issues related to the distribution of ULSD that are addressed in the study, including:

- The effects of the ULSD Rule on the U.S. oil distribution system both during and after the phase-in period
- How the distribution system would handle the second highway diesel product during the phase-in period, the infrastructure and investments required, and how the investments might be recouped
- The extent to which fuel contamination might occur when ULSD is shipped in common pipelines with other, higher sulfur products
- The capability of current testing methods to measure sulfur at the 15 ppm level
- The operational changes required in the distribution system, and how they will affect consumer costs.

In a followup letter dated January 24, 2001, the Committee on Science modified its initial request to reflect provisions included in the EPA's final rule. The Committee directed EIA to reflect the assumptions used by the EPA, to the extent possible. Where EPA's assumptions diverge meaningfully from industry expectations, EIA was asked to provide a sensitivity analysis. The Committee noted several issues that might require sensitivity analysis, including:

- The difference in production of 7 ppm versus 10 ppm diesel fuel
- The energy content of ULSD
- Fuel efficiency losses associated with engine after-treatment devices
- Additional distribution costs.

Background

The ULSD Rule represents a unique financial and logistical challenge to refiners and distributors, because it places an unprecedented low sulfur limit on a secondary product. Although highway-grade diesel, which is currently limited to 500 ppm sulfur, is the second most consumed petroleum product, gasoline is the most important product by far. In 1999, 500 ppm diesel accounted for 12 percent of total petroleum consumption while gasoline accounted for 43 percent.⁷ The ULSD Rule comes less than a year after a new nationwide sulfur standard for gasoline was finalized by the EPA at an average 30 ppm.⁸ Some concerns have been raised that resources may be both financially and physically challenged to meet both the gasoline and diesel sulfur standards.⁹

In February 2000, the EPA finalized a rule on Tier 2 vehicle emissions and gasoline sulfur standards. The sulfur content of gasoline across the country is to be phased down to 30 ppm on average between 2004 and 2007. Like the diesel sulfur standard, reduced sulfur gasoline is required in order to accommodate new emissions control technologies required for meeting tighter vehicle emissions standards. Gasoline produced by most refiners will be required to meet a corporate average sulfur content of 120 ppm in 2004 and 90 ppm in 2005, compared with a national average of around 340 ppm in 1998.¹⁰ By 2006, most refiners must meet a refinery level annual average of 30 ppm with a maximum of 80 ppm in any gallon.

Refiners producing most of their gasoline for the Geographical Phase-In Area (GPA), generally encompassing the Rocky Mountain region, will also be allowed a more gradual phase-in because of less severe ozone pollution in the area. These refiners will be required to meet a refinery average of 150 ppm in 2006 and must meet the 30 ppm requirement in 2007. Small refiners will not be

required to meet the 30 ppm standard until 2007. The date for GPA and small refiner gasoline sulfur compliance has been extended an additional 2 years for those refineries that produce 15 ppm diesel at 85 percent of baseline highway diesel production levels.¹¹

Consumption of highway-grade diesel (500 ppm sulfur) accounted for 68 percent of the distillate fuel market in 1999,¹² although 9 percent of that fuel went to non-road (rail, farming, and industry) and home heating uses.¹³ Higher sulfur distillate (more than 500 ppm) used exclusively for non-road and home heating needs accounted for the other 32 percent of the distillate market. These other distillate markets will also be affected by the new highway diesel standard and may play a role in how some refineries respond to the rule. For instance, instead of investing in ULSD production, some refineries may opt to switch production to non-road or heating markets.

The EPA is in the process of promulgating “Tier 3” non-road engine emission limits around 2005 or 2006, which are expected to be linked to sulfur reduction for non-road diesel fuel.¹⁴ The level of sulfur reduction required for Tier 3 vehicles is highly uncertain because of the diversity of the non-road market. Diesel engines used for farming, construction, rail, and other industrial markets have different performance requirements that need to be reconciled.¹⁵ Both the American Petroleum Institute (API) and National Petrochemical and Refiners Association (NPRA) have expressed concerns about complying with potential non-road standards before full implementation of the 15 ppm highway diesel standards.¹⁶

In addition to refinery issues, there are concerns about the ability of the distribution system to handle the requirements of the ULSD Rule. Between June 2006 and June 2010, the 80/20 rule will allow up to 20 percent of highway diesel production to continue at the current 500

⁷Energy Information Administration, *Petroleum Supply Annual 1999*, DOE/EIA-0340(99)/1 (Washington, DC, June 2000), Table 3.

⁸U.S. Environmental Protection Agency, “Control of Air Pollution from New Motor Vehicles: Tier 2 Motor Vehicle Emissions Standards and Gasoline Control Requirements,” *Federal Register*, 40 CFR Parts 80, 85, and 86 (February 10, 2000).

⁹National Petroleum Council, *U.S. Petroleum Refining: Assuring the Adequacy and Affordability of Cleaner Fuels* (June 2000), Chapter 3, U.S.A.

¹⁰U.S. Environmental Protection Agency, *EPA Staff Paper on Gasoline Sulfur Issues*, EPA420-R-98-005 (Washington, DC, May 1998). The average sulfur content has declined since the sulfur content of reformulated gasoline was reduced substantially to meet Phase 2 reformulated gasoline emissions requirements, which became effective in 2000.

¹¹The EPA announced on May 4, 2001, that National Cooperative Refining Association and Wyoming Refining would be given additional time to meet the sulfur standard for gasoline. Both refiners are planning to comply with the 2006 highway diesel requirements on time.

¹²Energy Information Administration, *Petroleum Supply Annual 1999*, DOE/EIA-0340(99)/1 (Washington, DC, June 2000), Table 3.

¹³Energy Information Administration, *Fuel Oil and Kerosene Sales 1999*, DOE/EIA-0525(99) (Washington, DC, September 2000), Tables 19-23.

¹⁴U.S. Environmental Protection Agency, *Reducing Air Pollution from Non-road Engines*, EPA420-F-00-048 (Washington, DC, November 2000), p. 3.

¹⁵Nonroad Workgroup, Minutes of the Workgroup’s Meeting (Alexandria, VA, January 16, 2000).

¹⁶*Diesel Fuel News*, Vol. 5, No. 3 (February 5, 2001).

ppm limit. That fuel must be segregated in the distribution system from the remaining 80 percent of highway diesel meeting the 15 ppm limit. As a result, some pipelines, terminals, and retail outlets may temporarily need to carry an extra diesel product, requiring capital investment for the additional infrastructure requirements and additional operating costs for distributing the extra product. Both pipeline operators and fuel marketers are concerned that contamination from higher sulfur petroleum products might require some ULSD to be downgraded to a higher sulfur product that would have a lower market value. Moreover, a second new distillate product may be required if Tier 3 requirements also become effective before 2010.

A number of groups representing refiners and retailers are taking legal action against the ULSD Rule, including the National Petrochemical and Refiners Association (NPRA), the American Petroleum Institute (API), the Society of Independent Gasoline Marketers of America (SIGMA), and the National Association of Convenience Stores (NACS). The four groups have cited concerns about the possibility of inadequate ULSD supply under the Rule. The retailer groups also oppose the phase-in provision of the ULSD Rule ("the 80/20 rule"), because it will temporarily require costly storage of an additional product. SIGMA's lawsuit also questions the feasibility of the 15 ppm sulfur limit on ULSD.¹⁷ On the other hand, the Rule has been strongly supported by a diverse coalition of environmental, manufacturing, regulatory, and trucking groups.¹⁸ State and local regulators are supportive of the ULSD Rule because it is an integral part of their State Implementation Plans for meeting air quality standards.

Some State and local areas have begun to set their own requirements for ULSD. Texas and Southern California have already finalized ULSD regulations, and the State of California is in the process of doing so.¹⁹ During the Bush Administration's review of the Federal ULSD rule,

a group of State and local air pollution regulators warned that more States would follow suit with their own regulations if the ULSD rule were delayed or changed in any way.²⁰

Methodology

In order to address both the short-term and mid-term supply issues identified by the Committee on Science, this analysis incorporates two different analytical approaches.

Refinery cost analysis addresses the uncertainty of supply in the short term. In addition, mid-term issues and trends are addressed through NEMS scenario analysis.²¹ Discussion of the key issues and uncertainties related to the distribution of ULSD is based on interviews with a number of pipeline carriers.

As suggested by the Committee, most of the major assumptions in this report are consistent with those used by the EPA in its Regulatory Impact Analysis (RIA) of the Rule. Before conducting this study, EIA consulted with representatives from diesel engine and emissions control manufacturers, the refining industry, and Government²² to discuss the methodology and assumptions. EIA also received input through EIA's Independent Expert Review program.²³ On the basis of the information received and a review of other analyses, EIA identified the analysis assumptions that contained the most significant uncertainties. Where possible, sensitivity analyses were developed to provide a measure of uncertainty in the projections.

Assessment of Short-Term Effects of the Rule

For the purpose of assessing the short-term supply situation as the new standard becomes effective in June 2006 (see Chapter 5), industry-level cost curves were

¹⁷ *Diesel Fuel News* (March 19, 2001).

¹⁸ The coalition includes the Alliance of Automobile Manufacturers, the American Lung Association, the Association of International Automobile Manufacturers, the Association of Local Air Pollution Control Officials, the California Trucking Association, the Clean Air Network, the International Truck and Engine Corporation, Manufacturers of Emission Control Association, the Natural Resources Defense Council, Northeast States for Coordinated Air Use Management, the Sierra Club, the State and Territorial Air Pollution Program Administrators, U.S. Public Interest Research Group, and the Union of Concerned Scientists.

¹⁹ Discussions with Mr. Bill Jordan, Texas Natural Resource Conservation Commission, and Mr. Tim Dunn, California Air Resources Board.

²⁰ *Diesel Fuel News*, Vol. 5, No. 4 (February 19, 2001).

²¹ Energy Information Administration, *National Energy Modeling System: An Overview 2000*, DOE/EIA-0581(2000) (Washington, DC, March 2000), www.eia.doe.gov/oiaf/aeo/overview/index.html.

²² Contact with diesel engine manufacturers included Cummins, Inc., Mack Truck, Inc., and Caterpillar, Inc. Contact with emission control manufacturers included Johnson Matthey and Engelhard Corporation. Refining industry contacts included the American Petroleum Institute (API), the Cenex Harvest States Cooperatives, UniPure Corporation, Equilon Enterprises, LLC, Lyondell Citgo Refining Company, Ltd., ExxonMobil Refining and Supply Company, Marathon Ashland Petroleum, LLC, and the National Petrochemical and Refining Association (NPRA). Government contacts included the U.S. Department of Energy's Office of Policy and Office of Transportation Technologies and the U.S. Environmental Protection Agency.

²³ Independent expert reviewers were Mr. Raymond E. Ory, Vice President, Baker and O'Brien, Inc.; Mr. Norman Duncan, Energy Institute, University of Houston; and Mr. Kevin Waguespack, PricewaterhouseCoopers.

constructed, based on refinery-specific analysis of investment requirements and operating costs.²⁴ Unlike the NEMS projections discussed below, the cost curves do not reflect an equilibrium market price.

The cost curves developed for this study are the result of a refinery-by-refinery analysis. Because of the proprietary nature of the data, this analysis does not disclose information about individual refineries. The ULSD production costs were estimated for different groups of refineries based on their size, the sulfur content of the feeds, the fraction of cracked stocks in the feed, the boiling range of the feed, and the fraction of highway diesel produced. The capital and operating costs for the different groups were developed for EIA by the staff of the National Energy Technology Laboratory (NETL).²⁵

The technology cost representations were used to develop four sets of cost curves based on four different investment rationales. Within a given supply curve, the relative costs of different groups of refineries provide an indicator of possible supply problems. A large range of compliance costs in which investment costs are much higher for some refiners than for others may be an indication that some refiners may forgo investment. The behavior of refiners will be influenced by their expectation of what others will do and is therefore subject to great uncertainty. In order to explore the uncertainty of refinery behavior and the possible implications for supply, cost curves were developed based on the four different scenarios of investment behavior discussed below:

- **Competitive Investment Scenario.** This scenario assumes that some refineries will produce ULSD in 2006, while others may find it more economical to abandon the market. Refiners that have competitive costs of production are assumed to maintain market shares similar to current highway diesel market shares. Refineries currently producing a relatively low fraction of diesel fuel may abandon the market unless their cost per unit is competitive at current highway diesel production levels.
- **Cautious Expansion Scenario.** Current producers with competitive cost structures for ULSD production and a high yield of diesel production (greater than 70 percent of middle distillates) are assumed to increase production if the unit cost of the increased production is not substantial. Other refineries may also increase their fraction of highway production if economical and if the non-road market will allow. For instance, the Northeast has a strong heating oil market, potentially limiting a shift toward highway diesel production.

- **Moderate New Market Entry Scenario.** This cost curve assumes that a selective number of refineries that are currently producing little or no highway diesel will enter the ULSD market. The underlying premise is that there would be a limited number of companies that think they will be able to gain market share without depressing margins to the extent of undercutting profits. Only a few will make this move, while the rest wait for a clear indication of ULSD margins.
- **Assertive Investment Scenario.** Refineries were assumed to make the requisite investments to either maintain or gain highway diesel market share.

The scenarios discussed above are based on capital cost and return on investment assumptions that are consistent with EPA's analysis. Due to the uncertainty of these assumptions, two sets of sensitivity analysis are also provided. To address the uncertainty associated with the cost of installing or modifying distillate hydrotreaters for producing ULSD, a set of scenarios was developed assuming capital costs for hydrotreater units that are about 40 percent higher than the initial set. An additional set of scenarios explores the impact of assuming a 10-percent after-tax rate of return on investment, used in most of the studies compared in Chapter 7, instead of the 5.2-percent after-tax rate (equivalent to 7 percent before tax) assumed in the initial set.

Assessment of Mid-Term Effects of the Rule

The mid-term analysis for this study was performed using the NEMS Petroleum Market Module (PMM). The PMM represents domestic refinery operations and the marketing of petroleum products to consumption regions. PMM solves for petroleum product prices, crude oil and product import activity (in conjunction with the NEMS International Energy Module and Industrial Demand Module), and domestic refinery capacity expansion and fuel consumption. PMM is a regional, linear programming representation of the U.S. petroleum market. Refining operations are represented by a three-region linear programming formulation of the five Petroleum Administration for Defense Districts (PADDs). PADDs I (East Coast) and V (West Coast) are treated as single regions, and PADDs II (Midwest), III (Gulf Coast), and IV (Rocky Mountains) are aggregated into one region. Each region is considered as a single firm where more than 80 distinct refinery processes are modeled. Refining capacity is allowed to expand in each region over each 3-year period. As a result, cumulative

²⁴The EPA and Baker and O'Brien also developed refinery-specific cost analyses, but their estimates did not reflect data related to the quality of crude oil inputs and the quality of diesel fuel components input to downstream units, collected by EIA.

²⁵The technology costs were developed in consultation with Mr. John Hackworth and were reviewed by Mr. Ray Ory, one of EIA's independent expert reviewers, and by members of API.

investment for any given year may include investment to meet future product expectations.

Unlike previous ULSD analysis sponsored by the EPA or industry groups, the PMM provides multi-year scenarios. These scenarios reflect market prices rather than average costs and implicitly include investment and import decisions. Because each model region operates as a single firm, the impact of the ABT refinery credit program is also implicitly represented. The PMM cannot differentiate between the costs of different types of refineries, but the impact of the temporary compliance option for small refineries is partially accounted for in this analysis by reducing the refinery production of ULSD by 4 percent prior to 2010.

The PMM was used to develop a ULSD Regulation case based on the provisions of the EPA's final ULSD Rule. Five sensitivity cases were developed for assumptions associated with greater uncertainty, as well as a Severe case, which combines the five sensitivity case assumptions in a single scenario, a No Imports case, and a 10% Return on Investment case. The eight alternative cases explore the impacts of the following assumptions:

- The capital costs associated with distillate hydro-treaters (the Higher Capital Cost case).
- The reliance of refineries on revamped equipment versus new equipment (the 2/3 Revamp case)
- The percentage of ULSD that is downgraded to a lower value product because of contamination from higher sulfur products in the distribution system (the 10% Downgrade case)
- The fuel efficiency loss associated with meeting new diesel emissions standards (the 4% Efficiency Loss case)
- The loss in ULSD energy content resulting from more severe desulfurization processes (the 1.8% Energy Loss case)
- The combined effects of the alternative assumptions in the previous five sensitivity cases (the Severe case)
- The impact of the ULSD Rule assuming that foreign imports meeting the new sulfur standards will not be available (the No Imports case).

- The rate of return on investment (the 10% Return on Investment case).

The PMM provides average annual marginal prices. Because of its aggregate regional and annual nature, the PMM cannot be used to address short-term supply issues. The results of the PMM scenarios assume that, in the long run, refiners will increase supply to meet demand.

Assessment of Distribution and Marketing Effects of the Rule

The temporary compliance and small refinery provisions were incorporated into the Final Rule as a “safety valve” to minimize potential supply problems by allowing up to 20 percent of a refinery's highway diesel fuel production to remain at the current 500 ppm sulfur standard between June 1, 2006, and May 31, 2010, and by allowing small refineries (representing about 5 percent of total diesel fuel production) to delay compliance with the new standard until June 1, 2010. These provisions provide flexibility to refiners during the transition period but will effectively require the distribution system to temporarily handle an additional product. Aside from carrying an additional product, the distribution system will face new challenges related to transporting a very-low-sulfur fuel in the same system with other, high-sulfur products. The discussion of the implications of the ULSD Rule for the pipeline distribution system (Chapter 4) is based on interviews with a number of pipeline companies representing a cross-section of size, capacity, location, markets, corporate structures, and operating modes.²⁶

The mid-term scenarios generated by the PMM include additional distribution costs associated with getting the ULSD to market during the transition period and after 2010. The incremental distribution costs reflect both the cost of capital for pipelines, terminals, and retail outlets and the costs associated with downgrading highway diesel that is contaminated during distribution. The capital component of the distribution costs used in this analysis is the same as that used in the EPA's Regulatory Impact Analysis (RIA) and is similar to those estimated by two other studies (Chapter 7). The cost of downgraded product is estimated by EIA using EPA's total

²⁶The companies that participated in the interviews included Buckeye Pipe Line Company, Colonial Pipeline, Conoco Pipe Line Company, Kaneb Pipeline Partners, L.P., Kinder Morgan Energy Partners L.P., Marathon Ashland Petroleum, LLC, TE Products Pipeline Company, L.P., and Williams Energy Services.

downgrade assumption of 4.4 percent and the price differential between ULSD and other diesel.²⁷ Estimates for the percent of downgraded product range between EPA's 4.4 percent estimate to 17.5 percent by Turner

Mason and Associates.²⁸ Due to the uncertainty about the extent of downgrade that will occur in the pipeline system, EIA has also projected the costs associated with larger downgrade assumptions (see Chapter 6).

²⁷U.S. Environmental Protection Agency, *Regulatory Impact Analysis: Heavy-Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Requirements*, EPA420-R-00-026 (Washington, DC, December 2000), Chapter V, web site www.epa.gov/otaq/regs/hd2007/frm/ria-v.pdf.

²⁸Turner, Mason & Company, *Revised Supplement to Report: Costs/Impacts of Distributing Potential Ultra Low Sulfur Diesel* (Dallas, TX, August 8, 2000).